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LIQUEFIED PETROLEUM GAS AS A BROODER FUEL [1]

By Jack G. Griffin, Agricultural Engineer, Agricultural Engineering Research Division

The possibility that brooder malfunctions are partly responsible for the condemnation of broilers is being investigated in Mississippi by workers at the South Central Poultry Research Laboratory, State College. It is suspected that stress produced by chilling of chicks may increase the incidence of airsacculitis, the largest cause of condemnation.

During cold winter weather, an operational problem arose at the laboratory in Mississippi in the management of brooders heated with LPG (liquefied petroleum gas). This is a report on the problem, with suggestions for correcting it.

LPG is used extensively as a fuel for brooders. Propane and butane are the main constituents of LPG. Except in rare instances, the fuel is a mixture of these two gases. In addition, LPG may contain propylene, isobutane, or butylene. Small amounts of ethane, ethylene, or isopentane may also be present. The temperature-pressure characteristics of commercial LPG are similar to those of pure propane and butane mixtures.

Broiler producers should be familiar with some of the properties of propane and butane so that they may better understand the actions of these gases. Propane and butane are similar in that at ordinary temperatures and at atmospheric pressure (14.7 p.s.i. absolute) both are in a vapor or gaseous state. They differ in some of their other properties.

Since most brooder systems require the gas to be in a vapor state, the boiling point of these materials is important. At 1 atmosphere of pressure, butane will boil (change from a liquid to a vapor) at +31.1° F. and propane will boil at -43.8°. At any temperatures below these and at atmospheric pressure, the materials will be in a liquid state. Therefore, at the same pressure propane will change from a liquid to a vapor at a much lower temperature than will butane. Also, at any temperature above their boiling points and at the same pressure, propane will change from a liquid to a gas at a faster rate than will butane. This is an important characteristic, since the fuel must be in a vapor state before it can be used for most brooders. During low temperature periods, butane might not vaporize fast enough to furnish sufficient vapor for the needs of the brooder; whereas propane might furnish the required amount.

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TABLE 1.--Properties of propane and natural butane

Material	Boiling point at 1 atm.	Weight of liquid at 60° F.	Gross heat		Freezing point
			Per pound	Per gallon	
	° F.	Lbs./gal.	B.t.u.	B.t.u.	° F.
Propane.........	-43.8	4.23	21,690	91,300	-305.9
Natural butane..	31.1	4.86	21,340	103,000	-217.0

For example, butane with a tank pressure of 25 p.s.i. will deliver 200 cubic feet per hour (c.f.h.) against 9.4 inches of H_2O delivery pressure through a No. 28 orifice. Butane needs a liquid temperature of 74° F. to produce a tank pressure of 25 p.s.i. Propane with a tank pressure of 25 p.s.i. will deliver 200 c.f.h. against 9.2 inches of H_2O delivery pressure through a No. 35 orifice. Propane has a tank pressure of 25 p.s.i. at a liquid temperature of 3°.

At 62° F. butane has a tank pressure of 10 p.s.i. and a delivery rate of 100 c.f.h. against 9.4 inches of H_2O delivery pressure through a No. 28 orifice. Therefore, when the temperature of butane drops from 74° to 62°, the delivery rate is halved. Propane has a much higher delivery rate than does butane at the same temperature and delivery pressure.

All temperatures (as used in this paper) are actual temperatures of the liquid fuel being considered. Usually, these temperatures will be different from those of the tank itself and of the air surrounding the tank. These differences in temperature result from changing weather conditions and the cooling effect of vaporization whenever gas is being withdrawn.

Normally at temperatures above 55° to 60° F., butane will vaporize fast enough to furnish the vapor required for the brooders. Propane will do this at a much lower temperature. Propane develops about the same tank pressure at -10° as butane develops at 70°.

Because LPG is often a mixture of butane and propane, distributors usually deliver fuel with a higher percentage of propane during low temperature periods than they deliver when the temperature is high. Sometimes the temperature drops so suddenly that the fuel does not have as high a percentage of propane as would be desired for good brooder operation. When butane and propane are both put into a tank, the propane will vaporize at a faster rate than the butane; and at low temperatures it is possible that most of the propane will vaporize and be used, leaving a mixture that progressively gets richer in butane. The gas suppliers have tanks of commercial propane that they can use to add to the mixture to increase the percentage of propane in the fuel during these low-temperature periods. A high percentage of propane during a hot period will cause an undesirably high pressure in the tank. To avoid this, gas suppliers deliver a higher percentage of butane in hot weather.

Table 2 gives the vapor pressures developed at different temperatures by the two gases. At 100° F. butane produces a tank pressure of 37.5 p.s.i., whereas propane produces a pressure of 172.3 p.s.i. Therefore, the gas suppliers regulate the ratio of butane and propane in the fuel to provide satisfactory operation at different atmospheric temperatures.

Another property to consider is the freezing point of each gas. For butane it is -217° F., and for propane it is -305.9°. During the below-zero period that occurred in Mississippi in the winter of 1961-62, trouble was experienced with some LPG systems. Poultry producers said that the fuel "froze," but of course the temperature did not get low enough to freeze either

TABLE 2.--Vapor pressures for propane and natural butane at different temperatures

Temperature of liquid (° F.)	Vapor pressure, p.s.i. absolute[1]	
	Propane	Natural butane
-10	31.5	5.6
0	38.2	7.2
10	46.0	9.2
20	55.5	11.6
40	78.0	17.7
60	107.1	26.3
80	142.8	37.6
100	187.0	52.2

[1] To convert absolute p.s.i. to gage pressure readings, subtract 14.7 from the absolute pressure.

butane or propane. It was low enough, however, to stop the vaporization of butane and to slow the vaporization of propane.

There are ways that the system can freeze at low temperatures and sometimes at above-freezing temperatures. The gas has been prepared to avoid the presence of water in the fuel. However, moisture may condense in the tanks and pipes of the system. During cold weather, this condensed moisture will collect as a frost in or near the regulator orifice where the fuel changes from a higher tank pressure to a lower constant delivery pressure. During the pressure change, gas expands; therefore, heat is absorbed from the surrounding area. To eliminate this type of freezing, the gas supplier adds a predetermined amount of antifreeze compound to the fuel. During cold weather, if you have this kind of trouble with an LPG system, call the supplier.

In another type of "freezing," moisture from the atmosphere condenses in the spring housing or bonnet of the regulator. The resulting ice formation stops the flow of gas. When this happens, introducing a small amount of glycerine into the spring housing overcomes the difficulty.

At temperatures below 31° F., condensates of butane may cause restriction in low points of the gas line. Thus, gas delivered to brooders may be pulsating because it bubbles through the trapped liquid. To prevent this, the pipe should be buried below the frostline, or it should have a drain or sump at the low point of the line.

During the winter of 1961-62, several methods were used in Mississippi to remedy this trouble during the low-temperature periods. Some producers built fires around the tanks. This furnished enough heat to vaporize the gas and make vapor available at the brooders.

<u>Under no circumstances should the tank be exposed to fire. This practice is dangerous.</u>

A small leak around the fittings in the tank or excess tank pressure from an uncontrolled fire could cause a dangerous explosion and fire. This practice is hazardous to the caretaker, his family, and the surrounding property, and it requires the caretaker to tend the fire and get firewood when he should be looking after the chicks. A request to the gas supplier to deliver propane to the tank could help correct the problem.

Butane and propane, like other fuels, require air for combustion. Complete combustion requires 15.49 pounds of air per pound of butane, and 15.71 pounds of air per pound of propane. Butane requires 3.58 pounds and propane 3.63 pounds of oxygen per pound of fuel. Sufficient air must be supplied to the burners to get complete combustion.

Burning 1 pound of butane produces 3.03 pounds of CO_2 and 1.55 pounds of water vapor plus other byproducts. One pound of propane will produce 2.99 pounds of CO_2 and 1.63 pounds of water vapor plus other byproducts. Sufficient ventilation must be provided in the house to remove carbon dioxide and water, or an excessive amount will accumulate. Such accumulations are believed detrimental to chick health. Butane and propane do not differ enough in these combustion properties to select one over the other as a fuel.

Butane and propane are both desirable in LPG mixtures. Their ratios are changed to obtain the most efficient and economical operation of brooders for broilers. Both gases must be handled with good judgment for safe operation.